CREDA

Yukon 8

Residential Solar Hot Water

CREDA is a program which has been jointly funded by Energy, Mines and Resources, Canada and the Yukon Government, Department of Economic Development and Tourism. For more information or copies of reports contact the Energy and Mines Branch, Yukon Government, Box 2703, Whitehorse, Y1A 2C6.

Frans
Plumbing
633-2551

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FOREWORD

The availability of secure and affordable energy supplies is a subject of national concern. Our primary energy sources are becoming more costly and less accessible. However, Canada has both the resources and technical expertise needed to develop renewable and alternative sources of energy.

The governments of Yukon and Canada have entered into a Conservation and Renewable Energy Demonstration Agreement as one means of pursuing this end. Cost shared by the territorial and federal governments, CREDA has a budget of $3.3 million and is dedicated to the development and demonstration of conservation and renewable energy technologies.

The objectives of CREDA:

- to develop and demonstrate promising new technologies, which, when widely adopted, will exploit renewable resources, conserve energy and/or use energy more efficiently.
- to develop broad public awareness of the potential of renewable energy and conservation technology.
- to provide opportunities for the commercial application of the technologies.
- to create economic spin-off benefits for manufacturing, industry and commerce.
- to create employment in new or existing energy-related industries.

The solar heating of domestic hot water project which is reported on in the following pages is an attempt to demonstrate the feasibility of using solar energy as an alternative to expensive conventional means. It is not expected to meet the total hot water heating requirements in a single family dwelling but whatever portion it meets means some conservation of non-renewable forms of energy.

EXECUTIVE SUMMARY

The following report examines the feasibility of using solar energy to preheat domestic water coming from the city supply at a temperature of approximately $4^{o}C$. The system was installed on an existing residence in Whitehorse, Yukon.

Four solar collectors totalling 7 m^2 were installed on a support structure facing south at an angle of 60^{o} from the horizontal. Heat from the solar system is transferred to the domestic water system via a heat exchanger in a 450 l storage tank. The solar system was operational for 10 months of the year and was only shut down in December and January because of the low angle of the sun and subsequent shading on the collectors.

The system worked most efficiently in the spring and early summer when the combination of long hours of sunshine, clean air and clear skies allowed for maximum availability of solar radiation. Performance dropped in late summer and fall mainly due to cloudier weather conditions. The average temperature in the storage tank over the 10 months of operation was $42^{o}C$, ranging from a high of 83^{o} C in July to a low of 6^{o} C in November. The system provided a total of 7.1 GJ, which is approximately one-third the annual requirement for domestic hot water heating.

Solar collectors can provide enough energy to preheat incoming cold water for most of the year but the capital costs are high and savings are relatively low resulting in a poor return on an investment for single family dwellings. Where greater volumes of water are heated, such as apartment buildings, hotels etc., greater savings can be realized, thereby making solar applications more economical.

Résumé pour l'exécutif

Le rapport suivant examine la possibilité d'utiliser l'énergie solaire pour réchauffer l'eau à usage domestique en provenance de l'aqueduc municipal; la température de cette eau est approximativement 4° C. Le système en question a été installé dans une résidence déjà existante à Whitehorse au Yukon.

Quatre collecteurs d'énergie solaire, dont la surface totalise 7 M^2, ont été installés sur une armature de soutien à un angle de 60 par rapport à l'horizontale et orientés vers le sud. La chaleur produite par ce système à l'énergie solaire est transmise à l'eau du système domestique par un échangeur de chaleur placé dans un réservoir d'emmagasinage d'une capacité de 450 l. Le système a fonctionné pendant 10 mois de l'année et son usage n'a été interrompu que durant les mois de décembre et janvier du fait que pendant cette période, le soleil ne s'élève pas assez haut au-dessus de l'horizon et les collecteurs demeurent dans l'ombre.

Le système a été le plus efficace au printemps et au début de l'été alors que la disponibilité de radiation solaire atteint son maximum à cause de multiples facteurs comme l'air pur, le ciel dégagé et les longues heures d'ensoleiilement. Le rendement a diminué en fin d'été et à l'automne surtout à cause du temps plus ennuagé. Pendant les dix mois d'opération, la température moyenne de l'eau dans le réservoir a été de 42° C, allant de 83° en juillet (la plus chaude température enregistrée) à 6° en novembre (la plus froide). Le système a fourni un total de 7.1 GJ, ce qui représente environ un tiers des besoins annuels d'un système de chauffage domestique servant à procurer de l'eau chaude.

Les collecteurs d'énergie solaires peuvent fournir suffisamment de chaleur pour réchauffer l'eau froide en provenance de l'aqueduc pendant la majeure partie de l'année, mais les coûts d'installation sont élevés et les économies réalisées sont relativement faibles; ce qui signifie que dans le cas de résidences unifamiliales, le retour sur l'investissement n'est pas très bon. Cependant, là où les besoins en eau chaude sont beaucoup plus grands, comme pour un hôtel, un édifice à logement, etc., de meilleures économies peuvent être réalisées, rendant ainsi l'utilisation d'un système à énergie solaire plus économique.

INTRODUCTION

Fran's Plumbing Ltd., Whitehorse, Yukon in conjunction with the Canada/Yukon Conservation and Renewable Energy Demonstration Program installed and tested a solar system for preheating domestic water. Fran's Plumbing Ltd. is a Whitehorse company established in 1977.

This solar system was the first to be installed in Whitehorse. Its purpose was to demonstrate to what extent solar energy will heat domestic water, to demonstrate how it performs year-round in a northern locality with low solar radiation levels and severe weather conditions in the winter, and to give an indication of how economically viable it is for private residential use.

The incoming water averages $4^{o}C$ over the year and hot water tank thermostats are generally set at $60^{o}C$. Because of the relatively high and ever increasing electrical rates it was thought that with the abundant supply of solar energy for most of the year it could be harnessed to reduce the temperature difference and save on energy bills.

Solar heating is a relatively new technology and has several factors in its favor for future use. It is a renewable source of energy which can be harnessed anywhere. Although the initial capital costs are high it has the potential for low operating costs. It involves relatively

small scale technology and installations can be made by local tradesmen. It can easily operate in conjunction with wood, oil or electric systems.

The solar system was installed in spring 1981 and began operation in mid-June. Records were kept until the following May to monitor various aspects of the system. It proved to be easy to install, reliable and virtually maintenance free.

SYSTEM DESCRIPTION

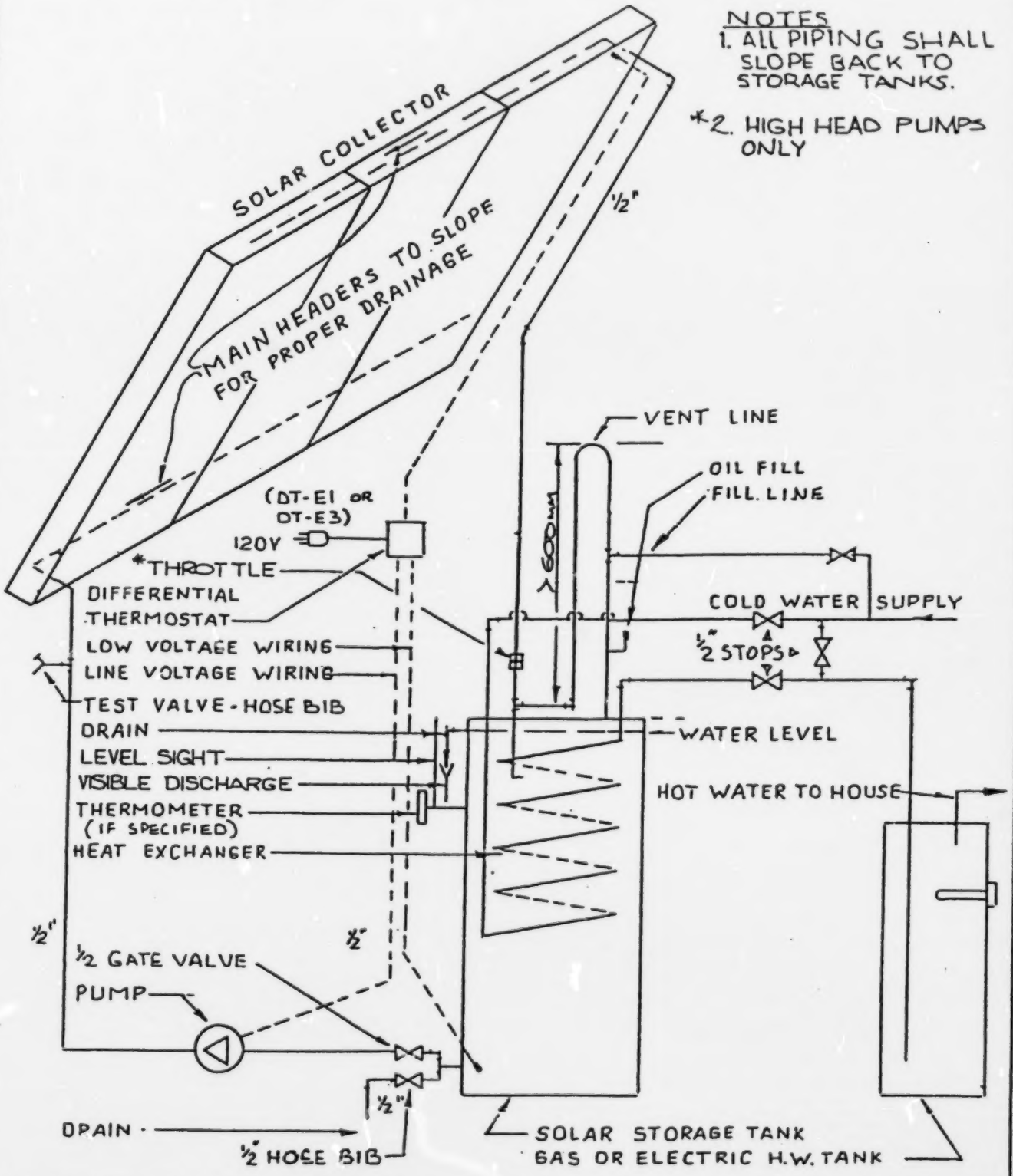
The solar domestic hot water preheating system was installed to preheat the incoming water at a temperature of approximately $4^{o}C$ and was built in conjunction with an oil fired system in an existing residence. The solar collectors and heat exchangers are manufactured by Solarsystems Industries Ltd., Richmond, B.C. and are designed for cold climate regions.

Four solar collectors totalling 7 m^2 were installed in series. The collectors have a single glazing with low-iron glass, a copper absorber with a selective black chrome surface and an aluminum frame. The storage tank is made of polypropylene and has a capacity of 450 l. An all-copper 8.5 l heat exchanger extends the full length of the tank. The pipes to and from the collectors and storage tank are insulated with 2.5 cm fibre insulation. A BTU meter was installed on the domestic hot water line to determine the heat output measured at the storage tank.

The system features a drain-down design with internal manifolds. It runs automatically with a pump suited to the difference in height from the tank top to the collector top. It is open to the atmosphere and cannot build up pressure. A differential thermostat controls the pump which operates when the temperature in the collectors is $5^{o}C$ warmer than the temperature in the storage tank and shuts off when the temperatures have equalized. The liquid in the solar system is water.

The collectors are set at an angle of 60^{o} from the horizontal which is the optimum angle for Whitehorse at 60^{o}N latitude. At the spring and fall equinoxes the sun's rays strike the collectors at the perpendicular which allows for maximum collection of energy. During the June and December solstices there is a large amount of deflection of the sun's rays.

The solar collectors were installed in the spring of 1981, and began operating mid-June. The system was shut down for the months of December and January 1981/82 due to the low angle of the sun and blockage of the sun's rays by trees.



Rev	BY	D	M	Y	
3	EWH	2	9	80	THROTTLING FITTING ADDED
2	EWH	2	9	80	ADDED OIL FILL, MOVED FILL LINE

APP

Solarsystems Industries Ltd.
5511-128 Street Surrey, B.C. Tel. 596-2665

	BY	D	M	Y
DRN	E.W.H	17	7	78
APP				

SCALE

DRAWING NO. A7.008 R2

DOMESTIC WATER HEATING PIPING SCHEMATIC 5

MONITORING

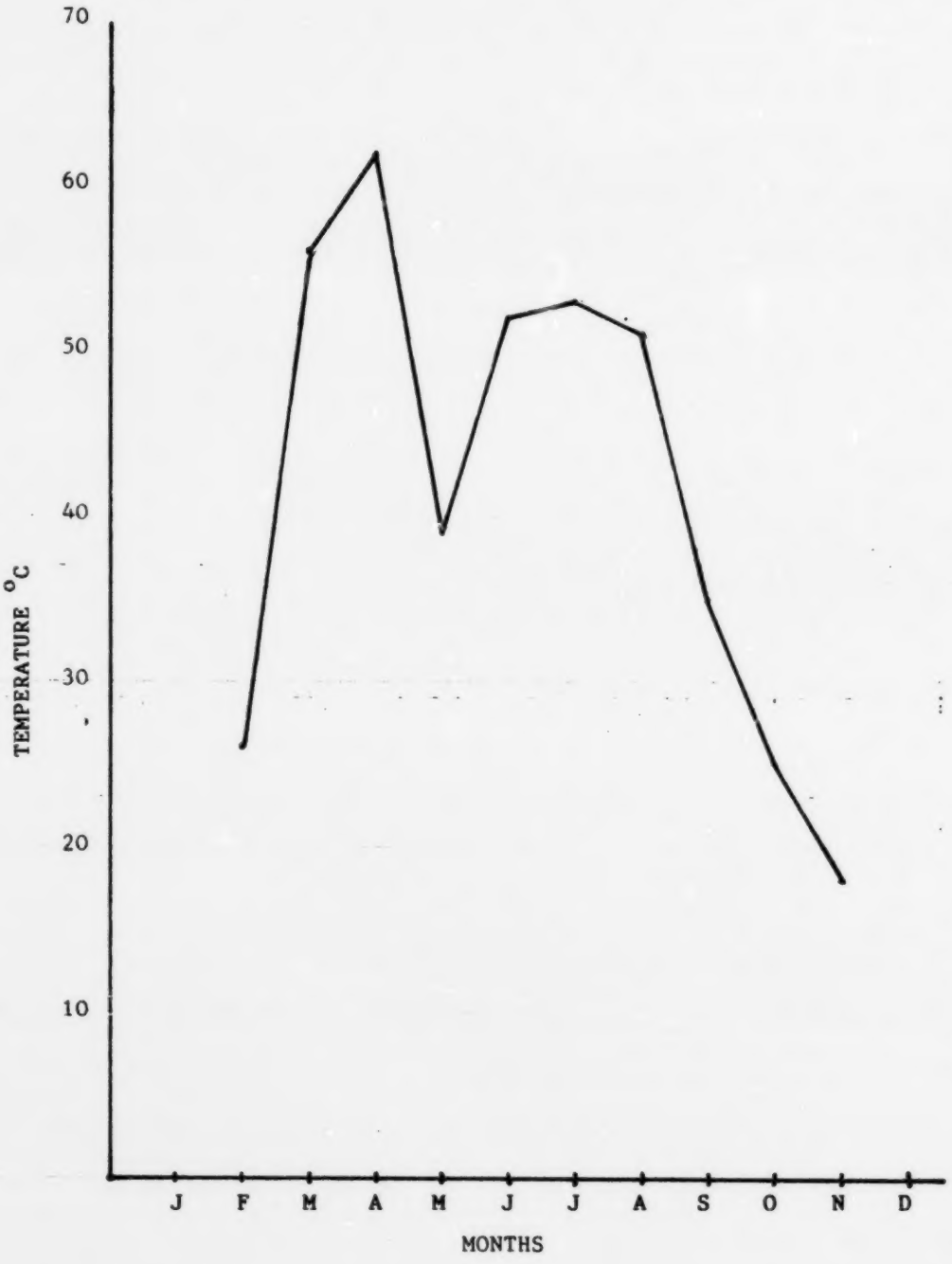
Data was kept for 10 months of operation during the first year on various aspects of the system and on some weather conditions. A BTU meter was installed to determine the heat output of the system measured at the storage tank. The number of hours the pump was running, the number of gallons of domestic hot water heated by the solar hot water, and the temperature of the storage tank were recorded. The weather conditions recorded were outside air temperature and cloud cover.

Data was recorded on 119 days out of a total of 288 days of operation during the first year. From the beginning of operation on June 16 to August 31 data was kept for 67 days, representing 56% of all data. Data for the late fall and early spring is somewhat sparse which means one has to extrapolate more often.

On the days when readings were taken there was no consistency as to the time of day. The arbitrary times of the readings and the increasingly sporadic recordings mean that it is impossible to get a truly accurate indication of performance.

FIGURE 1

AVERAGE DAILY TEMPERATURES OF STORAGE TANK



Source: D. Whittington

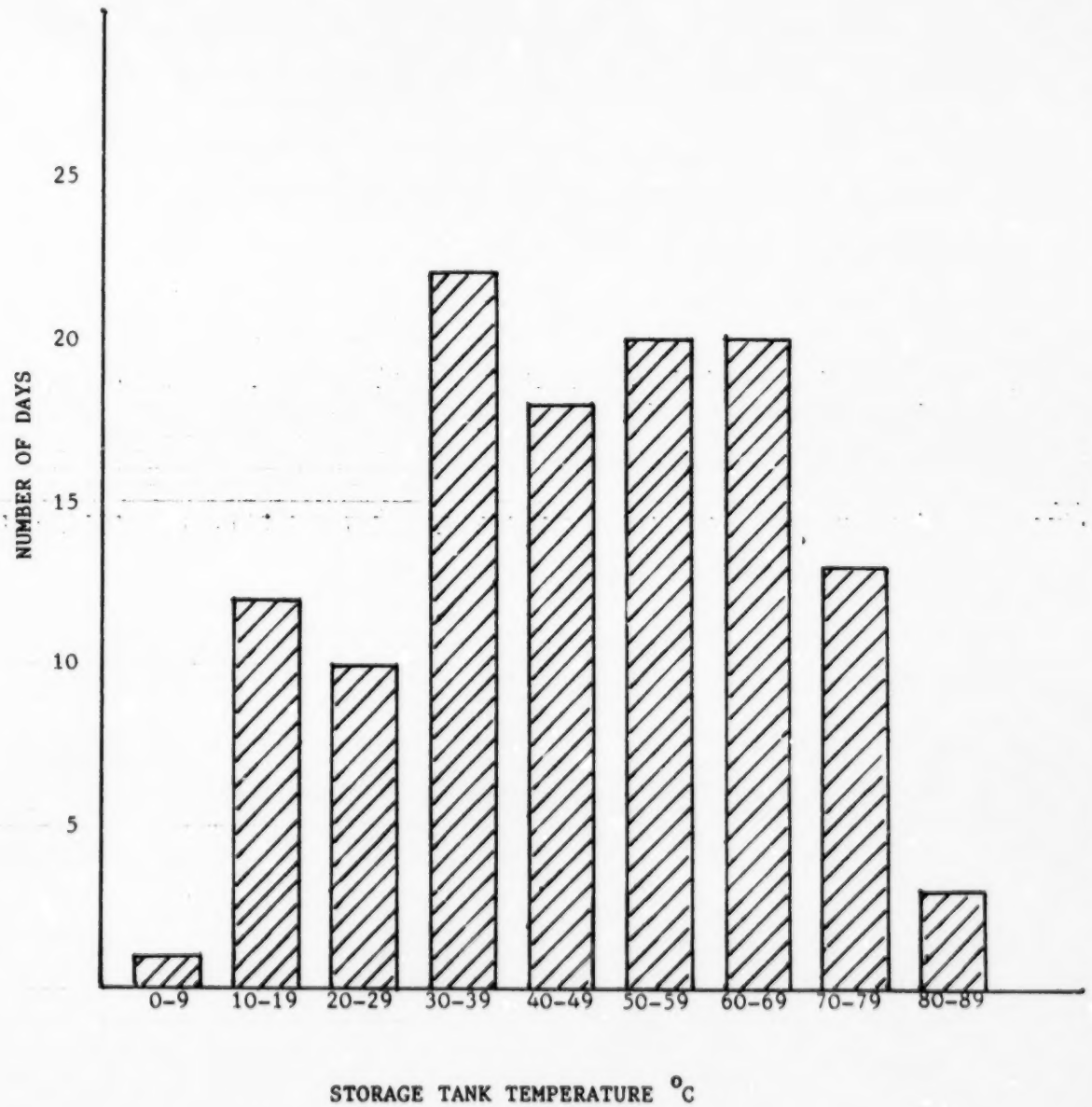
PERFORMANCE

As to be expected with a solar system sunny days resulted in considerable storage tank heating. It reached temperatures of 60^{o} - 83^{o}C on sunny summer days, and 45^{o} - 55^{o}C on sunny winter days when outside air temperatures were well below freezing (-10^{o} to -20^{o}C). It must be remembered that the most important factor in solar heating is the level of solar radiation, not the outside temperature. Days which were half sunny, half cloudy produced temperatures of 50^{o} - 60^{o}C in the summer and 15^{o} - 30^{o} C in the winter. Cloudy days resulted in temperatures of 25^{o} - 50^{o} C in the summer and 6^{o} - 20^{o}C in the winter. The average temperature of the storage tank over the 10 months was 42^{o}C. See Figures 1 and 2.

Although data for the late fall and early spring is somewhat sparse there is a strong indication that the solar system would provide a reasonable amount of energy in February, with output sharply rising in March and April. It is interesting to note that the highest average storage tank temperatures were recorded in March and April, traditionally the 6th and 5th sunniest months respectively. It is assumed that the reason for this was the fact that around the equinox the sun's rays are perpendicular to the plane of the collectors. The sun's rays are at the best angle again at the fall equinox but due to cloudier weather conditions typical of the fall the energy gain from the system is mediocre.

FIGURE 2

NUMBER OF DAYS STORAGE TANK REACHED VARIOUS TEMPERATURES



Total Number of Days: 119

Readings were taken at random between June 15, 1981 and May 31, 1982.

The total BTU's recorded on the meter was 4.9×10^6 or 5.2 GJ over an 8½ month period beginning the latter half of July to the end of November, and February to May inclusive. The daily average BTU's is shown in Figure 3. With storage tank temperatures and hours of sunlight being very similar in June and July it is reasonable to assume an additional 1.8×10^6 BTU's or 1.9 GJ would be gained during the time for which there was no data. A ten month total would be close to 6.7×10^6 BTU's or 7.1 GJ. This is not an exceptional amount as an electric hot water heater would consume approximately 21.6 GJ over the same period of time. The daily average number of gallons heated by the solar system is shown in Figure 4.

The pump circulating the water through the solar collectors operated for a total of 743 hours over the 10 month period. Pump time ranged from a high of 144 hours in May to a low of 30 hours in November. Figure 5 illustrates the daily average pump time.

The project proponents found the system to be virtually maintenance free. Topping up the liquid and checking the pump and differential thermostat is all that is required on an occasional basis.

FIGURE 3

DAILY AVERAGE BTU'S

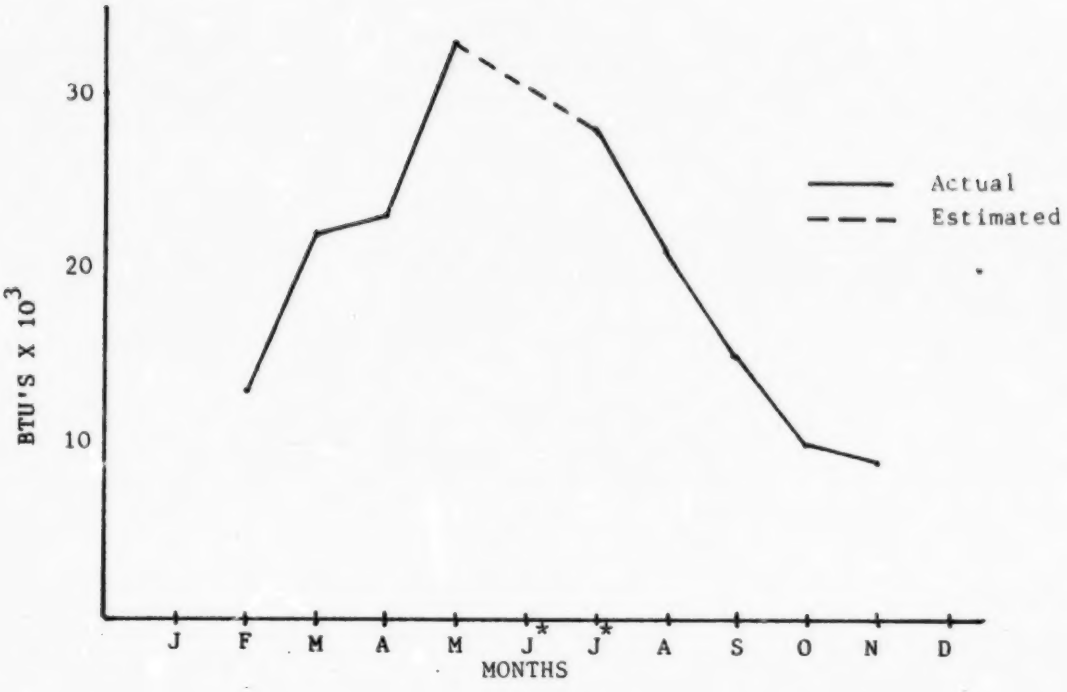
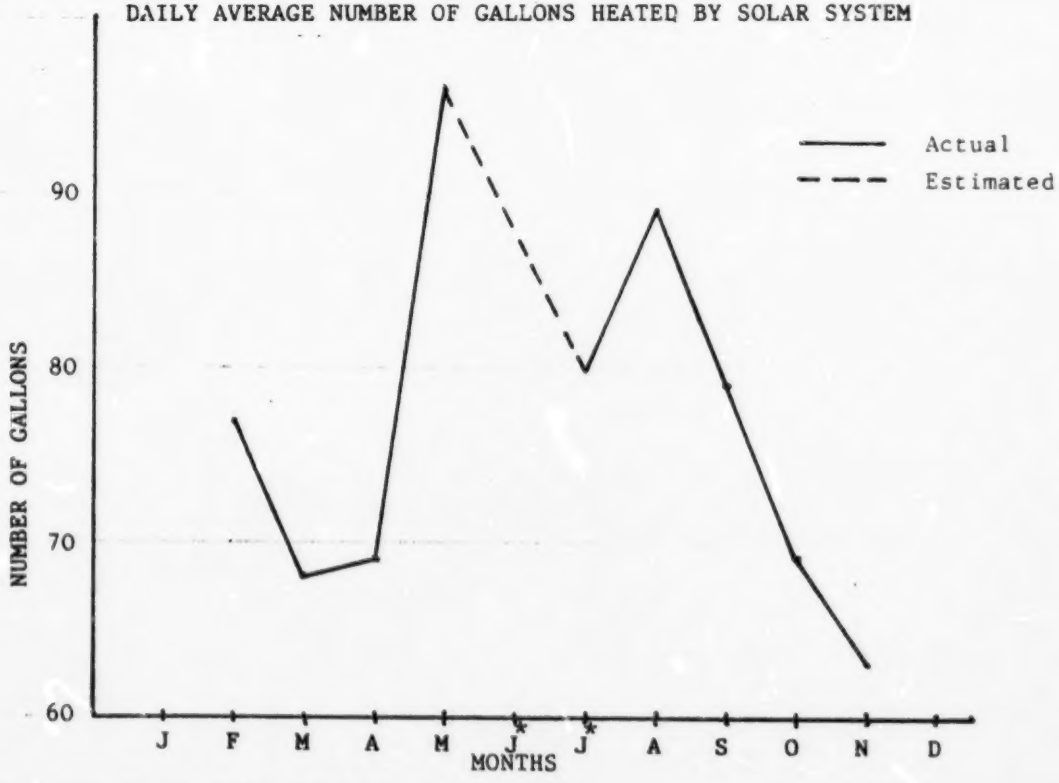


FIGURE 4

DAILY AVERAGE NUMBER OF GALLONS HEATED BY SOLAR SYSTEM

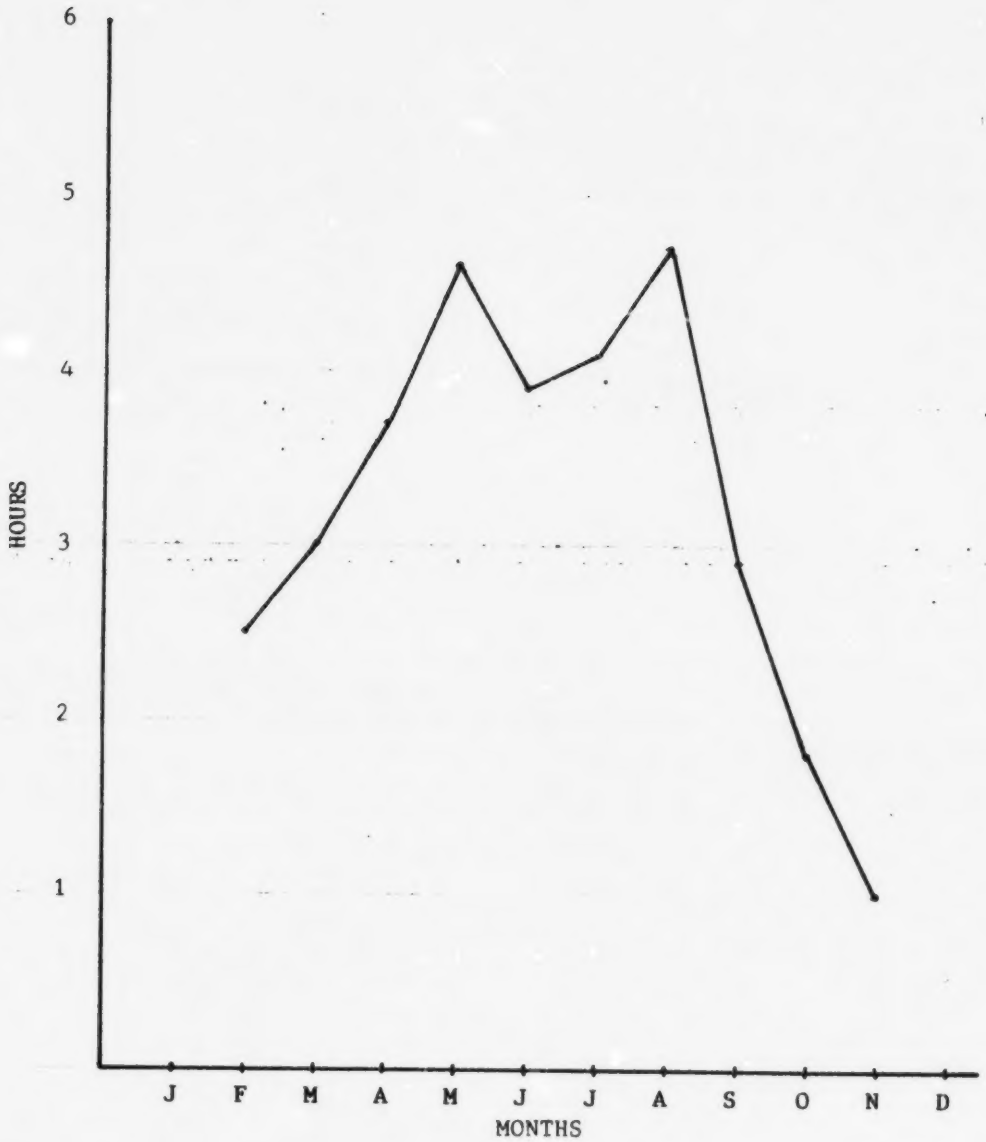


* No Data for June; July Data for 10 days only

Source: D. Whittington

FIGURE 5

AVERAGE DAILY HOURS OF PUMP OPERATING TIME



Source: D. Whittington

BUDGET REVIEW

It was estimated that the cost of purchasing and installing the solar system would be $5,600. The actual cost (excluding monitoring) was $6,300.

Budget to Actual	Budget	Actual
Solar panels	$1,900.00	$2,340.00
Storage tank	676.00	674.00
Miscellaneous hardware	1,258.88	1,392.76
Labour	1,440.00	1,182.50
Freight	350.00	367.60
Framing Costs		379.91
Sub Total	$5,624.88	$6,336.77
Monitoring		1,322.79
Total		$7,659.56

ECONOMIC BENEFITS

The economic benefits are best dealt with in terms of the savings the system will accrue to the project proponent and the number of years in which the system will have paid for itself.

The solar system produced 7.1 GJ of energy. The equivalent amount of oil needed to produce 7.1 GJ is 169 l. With a 55% efficiency of an oil boiler the actual amount of oil needed is 307 l. At a cost of $.45/l the savings accrued by using the solar system is $138.00 over the 10 month period. As the system is shut down for December and January it amounts to a savings of $138/year. This would be a 30% saving on annual fuel costs for hot water heating.

The cost of the solar system was $6,300. With an annual saving of $138 the payback time is 45 years. It hardly needs to be stated that in terms of an investment the solar system is of questionable value. The system cost $900/m^2.

Economic benefits in terms of jobs created industrial expansion and new markets are not viable considerations in the foreseeable future.

Grants, which would help make a solar system more economical, are available through the federal government under the Solar Energy Demonstrtion Program and Canadian Oil Substitution Program (COSP). See Appendix V.

POTENTIAL REPLICATIONS

Domestic solar hot water heating does not appear to be economical for private residential use with present technology. High capital costs make the recovery period too long for private residential users whose annual hot water bill would be in the $400 - $500 range. In order to recover capital costs in a reasonable time it is necessary to have a fairly high hot water heating bill. Commercial applications such as hotels, apartment buildings, restaurants or laundromats could be potential users. In the public sector hospitals and swimming pools could benefit from solar applications. Appendix III describes a solar installation on a 4-plex apartment building in Whitehorse.

The use of solar systems in commercial ventures is an even newer application than the use of solar systems in residences. There are certain standard assumptions made for solar applications in houses, but with commercial buildings or multiple unit residences each application is site specific for the many factors involved in determining the viability of using solar energy. Studies in Alberta, however, indicate that water heating in multiple housing units constitutes one of the most economically attractive applications of solar energy. With Yukon's energy prices being so much higher solar heating looks promising. Appendix IV describes the feasibility of a solar system on a motel.

ENERGY IMPACTS

Solar systems are clean and efficient in the sense that there is no wasted heat. They make use of an abundant and free source of energy which is constant from year to year. Perhaps the most important benefits of using solar energy is that it can be a way of conserving non-renewable energy and of saving on energy costs. In an area which depends on expensive imported fuels, especially when these expensive fuels are used to generate electricity, solar heating systems can offer protection against inflation and rising fuel costs. Although the initial capital costs are high and the technology is still very new, solar systems, when installed in a situation where cost recovery is short, can go a long way to help conserve other forms of energy and foster self-reliance.

The potential annual consumer saving, if buildings which use large volumes of hot water such as apartments, motels/hotels etc. install a solar system, is 2 million kWh or over $150,000. In addition there is the potential of 25 jobs and $600,000 income for the Yukon from a solar industry.*

Solar systems lend themselves very well to being used in conjunction with existing electric, oil or wood heating systems.

* Marvin Shaffer and Associates Ltd, The Economic Impact of Selected Energy Sources in Yukon, 1984

ENVIRONMENT IMPACT ASSESSMENT

Solar heating systems have virtually no detrimental environmental impact. There is no air pollution, no water pollution, no increase in waste heat. There are no transmission or on-going transportation costs. When solar collectors are used on rooftops or walls no additional land is used. A solar system does not involve combustion so there is no risk of fire.

It is a clean renewable source of energy and two of its virtues are that it can help conserve non-renewable sources of energy and foster self-reliance.

OTHER CONSIDERATIONS

Sizing of a solar system is of crucial importance and a complex problem involving a number of factors eg., collector area and performance, solar insolation, storage size heating requirements etc. A system designed for year-round solar domestic hot water heating usually requires 5 - 6 m^2 of collectors and can provide between 8 and 10 million BTU's, meeting approximately half to two-thirds of the hot water needs. For commercial applications determination of collector area and storage size needs a great deal of planning, especially as these are the most costly items.

The most critical factor for judging a region's solar heating ability is the amount of radiation that falls on a surface. The amount of solar energy reaching a particular point on the earth's surface depends on latitude, time of year, time of day and the amount of atmospheric absorption and scattering due to clouds, dust and water vapour. However these variation generally follow normal daily and annual cycles making it possible to estimate the feasibility of using solar energy. The hours of total bright sunshine for four Yukon communities are shown in Appendix I.

Another consideration would be electrical rates. Commercial rates are higher which would shorten the payback period. Residential and commercial rates are given for five Yukon communities in Appendix II.

Consideration of shading from trees etc. is an important factor. Deciduous or coniferous trees should not obscure the panels during useful heating hours. Relevant parts of the building must have access to direct sunlight for at least a six hour period of the day, preferably from 9:00 a.m. to 3:00 p.m.

CONCLUSIONS

At the present time domestic use of solar energy to heat water does not appear to be economically viable. High capital costs are the main stumbling block. As a solar system with present day technology can only be expected to meet half to two-thirds of the hot water energy demand the savings are not sufficient for the system to pay for itself within a few years. Capital costs will have to be reduced and conventional energy prices will have to increase considerably. As these two factors are happening along with improvements in technology, solar heating may in the future become economically viable.

Commercial applications are much more economical due to the larger volumes of water being used and therefore larger savings being realized, thus shortening the pay-back period.

Solar heating of domestic water is a relatively easy application as the demand is constant throughout the year. For commercial ventures such as hotels, demands for hot water will be higher in the summer but that coincides with the greater availability of solar energy.

APPENDICES

APPENDIX I

ACTUAL HOURS OF BRIGHT SUNSHINE - 30 year averages

	Whitehorse	Haines Junction	Fort Selkirk	Watson Lake
Jan	46.0	19.3	7.5	45.1
Feb	91.0	78.0	91.2	85.3
Mar	153.1	161.4	168.2	134.8
Apr	229.6	220.7	229.7	216.6
May	259.2	282.8	281.8	255.2
June	272.8	275.7	280.0	265.0
July	250.2	275.4	268.0	262.6
Aug	230.7	235.9	246.8	228.6
Sept	136.5	139.8	142.9	126.5
Oct	93.4	91.5	79.7	95.6
Nov	58.3	24.4	16.4	42.9
Dec	23.0	1.7	7.7	31.3
Total	1,843.8	1,806.6	1,819.9	1,788.9

APPENDIX II

ELECTRICAL SERVICE TARIFFS

RESIDENTIAL RATES ¢/kWh

kWh	Whitehorse	Watson Lake	Haines Junction	Pelly/Stewart Crossing	Dawson City	
0 - 200	7.2	18.1	15.1	26.2	0-300	15.5
201 - 500	6.7	16.4	14.0	23.7	300+	20.7
501 - +	6.3	14.6	10.7	18.3		

COMMERCIAL RATES

0 - 200	8.6	22.3	16.0	26.0	24.8
201 - 400	7.5	17.9	13.8	23.0	24.8
401 - +	6.3	14.7	10.6	18.3	24.8
kW demand	$1.10	2.25	1.65	1.95	4.45

For commercial users total energy charges are based on kW demand at an instantaneous moment. The bill is determined by the peak kW demand registered on the meter multiplied by the number of kWh used in a month. In fact very few commercial users go beyond the rate for 201 - 400 kWh.

APPENDIX III

Solar Application on a 4-plex Apartment and Comparison of the two Systems

A solar system was installed to heat the domestic water in a four-plex apartment building in Whitehorse. A total of 10 m^2 of glazed collectors are used and are set at an angle of 70^{o} from the horizontal (60^{o} angle would require major renovations). A 450 l storage tank with a heat exchanger is used to transfer the heat. The pipes are insulated with 5 cm rigid fibre insulation. The system uses a drain back design, and a differential thermostat controls the pump.

The system runs year round, although the pump ran for less than one hour in December. There have been no problems with freezing.

The system began operation in May, 1984 and the owner estimates that between then and the end of October 5,000 kWh have been saved. He estimates a further 1,000 - 2,000 kWh will be saved during the rest of the year. This translates into a savings of $525.00 to $600.00 per year. The solar system is supplying approximately 50 per cent of the hot water demands. With installation costs of $4,200 the payback period is about 7 years, which is a reasonable time for a commercial venture. Table 1 shows the decrease in average kWh consumption after the system began operating.

The difference between the commercial and the residential applications is in the volume of water used. Where greater volumes are used

greater savings can be realized even when the commercial solar application supplies a smaller percentage of hot water demands (50 percent as opposed to 60 percent in residential).

A system installed in Haines Junction which would save between 6,000 - 7,000 kWh on a 4-plex apartment, for example, would save $960 to $1,100 per year. In Watson Lake $1,300 to $1,500 would be saved on a similar project. Installation costs may be higher, but not enough to increase the payback period significantly.

Table 1

Average Daily kWh consumption in
4-plex for Domestic Hot Water

	1983	1984	Percent Change 1983 to 1984
January	35.5	42.8	+21%
February	44.4	43.9	0
March	34.7	40.5	+17
April	40.7	45.4	+12
May	44.9	31.5	-33
June	45.1	32.6	-28
July	34.2	15.5	-55
August	32.6	14.5	-56
September	33.7	18.7	-45
October	46.3	18.4	-60
November	46.1	31.8	-31
December	43.5	-	-

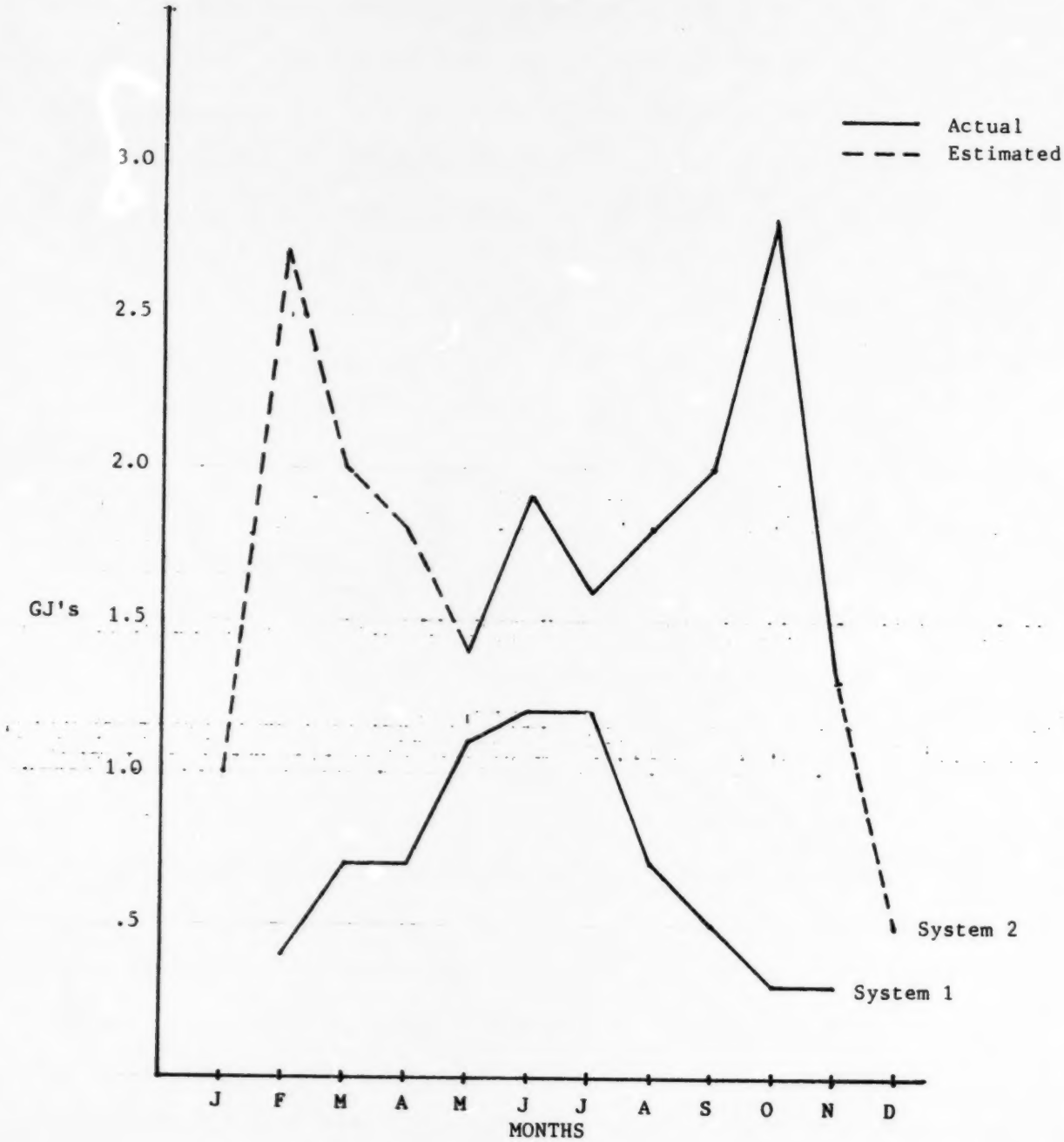
Figure 6 shows a comparison of the solar systems installed by Fran's Plumbing and on the 4-plex apartment. With Fran's Plumbing system the chart shows the solar energy produced as measured by a BTU metre at the storage tank, converted to GJ's. With the solar system on the 4-plex the chart shows the energy that has been saved on the electrical bills by comparing kWh consumption for domestic hot water for each month before and after installation. As the system began operation on May 6, 1984 data in not available for the full year.

Data is available from May to November. Estimates have been made for the rest of the year based on comparable hours of sunshine for the months for which data is known. For example, since August and April each have on the average 230 hours of sunshine it is assumed a similar solar energy gain can be realized in April that was realized in August. Actual hours of sunshine can vary considerably from the 30 year average, but it is expected to even out over the year.

The savings in electrical consumption from October 1983 to October 1984 were considerable. This could be explained by the fact that October 1984 was sunnier than usual and that the solar collectors are set at 70^{0} from the horizontal. In October the altitude of the sun from the horizon is 20^{0}, which means the sun's rays strike the collectors at the perpendicular, the optimum angle for solar collection. In February the sun is again 20^{0} above the horizon; this plus comparable hours of sunshine to October should mean another peak in energy gain could be expected.

FIGURE 6

COMPARISON OF TWO SOLAR SYSTEMS
AVERAGE MONTHLY GJ'S



SYSTEM 1 - Domestic Hot Water - Fran's Plumbing
Year total - 7.1 GJ

SYSTEM 2 - Domestic Hot Water - 4-Plex Apartment
Estimated year total - 20.8 GJ

One reason for the drop in solar energy production in the summer may be due to shading from the roof overhang. The combination of some shading, even 15 - 20%, plus the deflection caused by the sun's rays being at a 60^{0} angle to the collectors would reduce the efficiency of the collectors. The total number of hours of sunshine would help mitigate this situation.

A total of 7.1 GJ was gained by Fran's Plumbing's solar system. The four-plex gained 12.8 GJ over a 7 month period. A yearly saving of 21.9 GJ could be realized, the equivalent of 6,000 kWh or $516 (@ 1984 rates).

Appendix IV

Feasibility of a Solar System for a Motel

The annual average daily radiation on a south facing collector inclined at 70^{0} from the horizontal at Fort Smith, Alberta 60^{0}N latitude is 1,086 BTU/ft² day, or .0123 GJ/m² day.* Whitehorse is very close to 60^{0}N and would therefore receive approximately the same amount of radiation. The yearly radiation would be 4.49 GJ/m².

A commercial building such as a 30 unit motel using 180 litre of water per day per unit would require 1.27GJ/day to heat the domestic hot water from approximately 4^{0} C to 60^{0} C. A total of 464 GJ/year is needed. With solar radiation at 4.49 GJ/m² the surface area required is 103 m².

The cost of heating the water by electricity would be $900/month @8.6¢/kWh. This is based on a 100% occupancy rate which does not happen over the year. Assuming four months at each of 100%, 50% and 25% occupancy rate over the year the electric bill for hot water heating would be around $6,000 per year.

The cost of installing a system depends on many factors, most of which are site specific e.g. storage capacity, existing infrastructure etc. Government grants are available at the present time to the tune of $110/GJ or 60%, whichever is less. Giving a wide range of the cost

* Department of Energy and National Resources, Government of Alberta, Prospects for Solar and Wind Energy Utilization in Alberta, 1978.

from $400/m², $600/m² and $800/m² with the system requiring 100 m² and using grant money available costs could vary from $16,000 to $24,000 to $32,000.

Cost/m²	Cost for 100 m²	Grant * Available 60%	Cost to Proponent
$400	$40,000	$24,000	$16,000
600	60,000	36,000	24,000
800	80,000	48,000	32,000

* $110/GJ for 464 GJ = $51,040, the 60% alternative is less.

If electrical costs for domestic hot water are in the nature of $6,000/year payback periods could range from 2.7 to 5.3 years.

This is a very generalized analysis of using a solar system in a commercial application. Careful economic evaluation is necessary to determine the system design that will provide energy at the lowest cost over the life of the system. The analysis must take into account the capital costs of the solar project, the predicted costs of conventional energy for the projected life of the system, and the cost of operating the back up system. However, domestic water heating in multiple housing units is one of the most economically viable uses of solar energy.

Appendix V

Federal Grants Available

Solar Domestic Hot Water Program

Energy, Mines and Resources currently subsidizes the cost of installing a solar domestic water heater through contribution payments of up to $1,500 to companies participating in the program. As of October 1, 1984 payments of $1,200, $1,400 and $1,500 are made for each system and the amount is determined according to the amount of energy it is capable of delivering. Reduction in the payment amounts will match corresponding drops in the selling price. Only approved systems are eligible and they must be installed on either a commercial or residential building as a complete, single domestic hot water package. The installations must be carried out either by the company selling the equipment or by recognized subcontractors. All systems must carry a three-year warranty and be installed according to the manufacturer's installation specifications using the Canadian Solar Industries Association's "Manual for the Installation of Residential Solar Hot Water Systems" as a quality control.

Commercial and industrial ventures can also benefit from cost-sharing agreements with EMR. The amount of government assistance to the applicant will be based on the cost and performance of the system. As of October, 1984 the maximum is 60% or $110 per GJ and the

contribution will gradually drop over the life of the program. The successful applicant will undertake the design, installation, commissioning, operation and maintenance of the system. Inspections will be carried out to ensure that quality control specifications are met.

Canadian Oil Substitution Program (COSP)

To be eligible for funding under this program the complete Solar Domestic Hot Water system must have a COSP acceptance number and be installed by a sub-contractor participating in this program. Approved systems may be installed on either residential or commercial buildings but are only eligible for the grant if installed as a complete single unit. The grant level to install a "C" system is a flat $1,500 regardless of selling price. Systems "A" and "B" have smaller grants, depending on their size and potential capacity. The grant application is arranged for by the contractor. The remaining installation cost, after the Domestic Hot Water grant funding has been subtracted, may be claimed under the COSP.

Energy, Mines and Resouces Canada | Énergie, Mines et Ressources Canada

Yukon
Department of Economic Development and Tourism

RESIDENTIAL SOLAR DHW

Final Project Summary

Canada/Yukon Conservation and Renewable Energy Demonstration Program

Project No.
3766-4-8

Date:
June 1982

Sectors:
Domestic Hot Water

Project Locations:
Whitehorse, Yukon

Technology:
Solar

Jurisdiction:
Yukon

Project Manager:
D. Whittington

Status:
Completed

Simple Payback:
45 years

Purpose:

To demonstrate to what extent solar energy will heat domestic hot water in a northern climate.

Description:

A four collector (7 m²) drainback solar DHW system was installed on an existing home in Whitehorse.

Contributors:

Applicant	$2,659
Canada/Yukon	5,000
	$7,659

Demonstrated Benefits:

The solar system provided approximately one-third of the energy required to heat DHW.

Further Information

D. Whittington, 907 Grove Street, Whitehorse, Yukon.
David Arseneault, Energy and Mines Branch, Economic Development and Tourism, Government of Yukon, Box 2703, Whitehorse, Yukon Y1A 2C6, phone (403)667-5384.

Economic Analysis:

Materials - Collectors	$2,340.00
Plumbing	2,066.76
Labour	1,182.50
Framing Costs	379.91
Freight	367.60
	$6,336.71

Annual savings in fuel equivalent is $138. The payback period is 45 years at current oil prices. Domestic hot water heating by solar energy is uneconomical because of the high cost of parts and installation for the relatively small amount of water being heated.

Technical Details:

7 m^2 of solar collectors were set on a south facing support structure at an angle of 60^0 from the horizontal. Water heated in the collectors drained down into a 450 litres storage tank containing a 8.5 litre coil to heat the domestic water. A differential thermostat operated the pump to circulate the water back to the collectors.